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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/605,345	09/24/2003	Shyh-Ing Wu	10232-US-PA	2344

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JIANQ CHYUN INTELLECTUAL PROPERTY OFFICE
7 FLOOR-1, NO. 100
ROOSEVELT ROAD, SECTION 2
TAIPEI, 100
TAIWAN

EXAMINER	
DOTY, HEATHER ANNE	
ART UNIT	**PAPER NUMBER**
2813	

DATE MAILED: 03/07/2006

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	10/605,345	WU, SHYH-ING	
	Examiner	Art Unit	
	Heather A. Doty	2813	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *14 December 2005*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-11 and 13-21* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-11 and 13-21* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *24 September 2003* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☒ All b)☐ Some * c)☐ None of:

1.☒ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

Claim Objections

The amendment to claim 21 has overcome the objection made to claim 21 in the Office action dated 9/14/2005.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Claims 1-3, 7, 9, 10, 12-16, 18, 19, and 22 are rejected under 35 U.S.C. 103(a) as being unpatentable over Applicant's Admitted Prior Art (APA) in view of Lu et al. (U.S. 6,440,836).

Regarding claim 1, APA teaches a process for forming a plurality of bumps on a wafer with an active surface, wherein the wafer further includes a passivation layer, a polymer layer and a plurality of bonding pads over the active surface, and the bonding pads are exposed by a plurality of first openings in the passivation layer and the polymer layer (instant specification paragraph 0007), the process comprising the steps of:

--forming an adhesion layer over the active surface of the wafer covering the bonding pads and the polymer layer (instant specification paragraph 0008);

--forming a barrier layer on the adhesion layer (instant specification paragraph 0008);

--forming a wettable layer on the barrier layer (instant specification paragraph 0008);

--removing a portion of the wettable layer and a portion of the barrier layer such that the residual wettable layer and the residual barrier layer remain on the bonding pads (instant specification paragraph 0009 and Fig. 1C);

--forming a patterned mask layer, wherein the mask layer has a plurality of second openings that at least exposes the wettable layer (instant specification paragraph 0010 and Fig. 1D);

--performing a printing process to form a solder paste layer inside the second openings by depositing solder paste into each second opening (instant specification paragraph 0011 and Fig. 1E), wherein the solder paste layer includes solder powders and a flux (instant specification paragraph 0014);

--performing a first reflow process to transform the solder paste layer inside each second opening into a bump (instant specification paragraph 0012 and Fig. 1F); and

--removing the patterned mask layer (instant specification paragraph 0013).

APA does not teach that the step of forming the patterned mask layer includes forming the mask layer on the adhesion layer, and it does not teach removing the adhesion layer outside the residual wettable and the residual barrier layer.

Lu et al. teaches a method of forming a plurality of bumps on a wafer, the process comprising the steps of forming an adhesion layer (column 7, line 54 – column 8, line 6; **82** in Fig. 3B), a barrier layer (**84** in Fig. 3B), and a wettable layer (not labeled,

but considered part of BLM layer **80** in Fig. 3B; column 7, line 67 – column 8, line 1), removing a portion of the wettable layer and a portion of the barrier layer (Fig. 3D shows upper levels of the BLM layer removed from the regions not on the contact pad **72**), forming a patterned mask layer (**100** in Fig. 3G) on the adhesion layer, and removing the adhesion layer outside the residual wettable and the residual barrier layer (Fig. 3I). Lu et al. teaches that this method enables an improved process for fabricating fine-pitched solder balls on any suitable electronic substrate (column 9, lines 19-22).

Therefore, at the time of the invention, it would have been obvious to one of ordinary skill in the art to modify the bump-forming method taught by APA by removing portions of the wettable and barrier layers only, and then forming the patterned mask layer over the adhesion layer, as shown in Figs. 3D-3G of Lu et al., and after forming the solder layer, removing the remaining adhesive layer not under the solder, as shown in Fig. 3I of Lu et al. The motivation for doing so at the time of the invention would have been that the method taught by Lu et al. enables an improved process for fabricating fine-pitched solder balls on any suitable electronic substrate.

Regarding claim 2, APA and Lu et al. together teach the process of claim 1. APA further teaches performing a second reflow process to treat the bumps (instant specification paragraph 0013).

Regarding claims 3 and 7, APA is silent regarding the material composition of the adhesion and wettable layers. However, Lu et al. teaches that the adhesion layer is comprised of aluminum and the wettable layer of copper (column 7, lines 34-39). Therefore, at the time of the invention, it would have been obvious to one of ordinary

skill in the art to form a bump using the method taught by APA and Lu et al. together, and taught by claim 1, and further make the adhesion layer of aluminum and the wettable layer of copper. The motivation for doing so at the time of the invention would have been that these are normal materials for such applications, as taught by Lu et al. (column 2, lines 28-30) and using them would save the time and resources involved in developing alternative materials.

Regarding claim 9, APA and Lu et al. together teach the process of claim 1. APA is silent regarding the composition of the bonding pads, but Lu et al. teaches that the bonding pads are made of aluminum (column 2, lines 12-14). Therefore, at the time of the invention, it would have been obvious for one of ordinary skill in the art to form a bump using the process taught by APA and Lu et al. together, and also taught by claim 1, and form the bonding pads of aluminum because it is a conductive metal, and a conventional material for such an application, as taught by Lu et al. (column 2, lines 8-14).

Regarding claim 10, APA and Lu et al. together teach the process of claim 1. Lu et al. further teaches that the bonding pads are made of aluminum (see rejection of claim 9 above) and that the under-bump-metallurgy is an aluminum/nickel-vanadium alloy/copper composite layer (see rejection of claims 3, 6, and 7 above).

Regarding claim 13, APA teaches a process of fabricating bumps on an active surface of a wafer, comprising the steps of:

--forming a first under-bump-metallurgy layer on the active surface of the wafer;

--forming a second under-bump-metallurgy layer on the first under-bump-metallurgy layer;

--removing a portion of the second under-bump-metallurgy layer;

--forming a patterned mask layer, wherein the mask layer has a plurality of openings that at least exposes the second under-bump-metallurgy layer;

--performing a printing process to deposit a solder paste layer into the openings, wherein the solder paste layer is made of a mixture including solder powders and a flux (instant specification paragraph 0014);

--performing a first reflow process to transform the solder paste layer inside the openings into bumps; and

--performing a second reflow process to treat the bumps (see instant specification paragraphs 0008-0013).

APA does not teach that forming the patterned mask layer includes forming the patterned mask layer over the first under-bump-metallurgy layer, or removing the first under-bump-metallurgy layer outside the residual second under-bump-metallurgy layer.

Lu et al. teaches a method of forming a plurality of bumps on a wafer, the process comprising the steps of forming a first under-bump-metallurgy layer (adhesion layer, column 7, line 54 – column 8, line 6; **82** in Fig. 3B), a second under-bump-metallurgy layer (**84** in Fig. 3B; column 7, line 67 – column 8, line 1), removing a portion of the second under-bump-metallurgy layer (Fig. 3D shows upper levels of the BLM layer removed from the regions not on the contact pad **72**), forming a patterned mask layer (**100** in Fig. 3G) over the adhesion layer, and removing the adhesion layer outside

the residual wettable and the residual barrier layer (Fig. 3I). Lu et al. teaches that this method enables an improved process for fabricating fine-pitched solder balls on any suitable electronic substrate (column 9, lines 19-22).

Therefore, at the time of the invention, it would have been obvious to one of ordinary skill in the art to modify the bump-forming method taught by APA by removing portions of the second under-bump-metallurgy layer only, and then forming the patterned mask layer over the adhesion layer, as shown in Figs. 3D-3G of Lu et al., and after forming the solder layer, removing the remaining adhesive layer not under the solder, as shown in Fig. 3I of Lu et al. The motivation for doing so at the time of the invention would have been that the method taught by Lu et al. enables an improved process for fabricating fine-pitched solder balls on any suitable electronic substrate.

Regarding claims 14 and 18, APA and Lu et al. together teach the process of claim 13. APA further teaches that the second under-bump-metallurgy layer at least comprises a wettable layer and an adhesion layer (instant specification paragraph 0008).

Regarding claims 15 and 19, APA and Lu et al. together teach the process of claim 13. APA is silent regarding the material composition of the wettable and adhesion layers, but Lu et al. teaches that a material of the wettable layer comprises copper and the adhesion layer is made of titanium (column 2, lines 28-30; column 7, lines 37-38; column 8, lines 1-3). Therefore, at the time of the invention, it would have been obvious to form a bump using the process taught by APA and Lu et al. together, and also taught by claim 13, and further make the wettable layer from copper. The motivation for doing

so at the time of the invention would have been that these are normal materials for such applications, as taught by Lu et al. (column 2, lines 28-30) and using them would save the time and resources involved in developing alternative materials.

Regarding claim 16, APA and Lu et al. together teach the process of claim 14. APA further teaches that the step of forming a second under-bump-metallurgy layer on the first under-bump-metallurgy layer further includes the steps of forming a barrier layer on the first under-bump-metallurgy layer and forming the wettable layer on the barrier layer (instant specification paragraph 0008).

Claims 6 and 17 are rejected under 35 U.S.C. 103(a) as being unpatentable over Applicant's Admitted Prior Art (APA) in view of Lu et al. (U.S. 6,440,836) and Cronin et al. (U.S. 6,140,703).

Regarding claims 6 and 17, APA and Lu et al. together teach the process of claims 1 and 16. APA is silent regarding the composition of the barrier layer, but Lu et al. teaches that a material of the barrier layer includes nickel-vanadium alloy (column 7, line 38). Therefore, at the time of the invention, it would have been obvious to form a bump using the process taught by APA and Lu et al. together, and also taught by claim 16, and further make the barrier layer from a nickel-vanadium alloy. The motivation for doing so at the time of the invention would have been because a composition of nickel and vanadium forms a barrier that inhibits the dissolution of nickel and its subsequent diffusion during solder reflow processes, as expressly taught by Cronin et al. (column 2, lines 54-56).

Claims 4, 5, 20, and 21 are rejected under 35 U.S.C. 103(a) as being unpatentable over Applicant's Admitted Prior Art (APA) in view of Lu et al (U.S. 6,440,836) and further in view of Agarwala (U.S. 5,376,584).

Regarding claims 4, 5, 20, and 21, APA and Lu et al. together teach the processes of claims 1 and 19. They do not teach that the step of removing the adhesion layer comprises using an etching solution for etching the adhesion layer, wherein the etching solution does not react with the bumps.

Agarwala teaches a method of forming a bump that comprises etching an adhesion layer after the bump is formed using an etch solution that does not react with the bump (column 4, lines 33-38; since the solder bump is reflowed after the chemical etch, it is inherent that the etch did not react with the bump).

Therefore, at the time of the invention, it would have been obvious to one of ordinary skill in the art to use the method taught by APA and Lu et al. together, and also taught by claims 1 and 19, and further remove the adhesion layer using an etch solution that does not react with the bumps. The motivation for doing so at the time of the invention would have been to protect the bumps for future processing steps such as reflow, as taught by Agarwala et al. (column 4, lines 37-38).

Claim 8 is rejected under 35 U.S.C. 103(a) as being unpatentable over Applicant's Admitted Prior Art (APA) in view of Lu et al. (U.S. 6,440,836) as applied to claim 1 above, and further in view of Kim et al. (U.S. 6,417,089).

Regarding claim 8, APA and Lu et al. together teach the method of claim 1, but do not teach that the polymer layer is made of a material selected from the group consisting of benzocyclobutene and polyimide.

Kim et al. teaches forming an insulation layer above a passivation layer and beneath an under-bump-metallurgy layer wherein the insulation layer comprises a polymer selected from the group consisting of benzocyclobutene and polyimide (column 3, lines 26-35). Therefore, at the time of the invention, it would have been obvious to one of ordinary skill in the art to form a bump according to the method taught by APA and Lu et al. together, and also taught by claim 1, and further make the polymer layer from benzocyclobutene or polyimide, since it is known in the art to do so, as taught by Kim et al. Further, it has been held that the selection of a known material based on its suitability for its intended use supports a prima facie obviousness determination (*Sinclair & Carroll Co. v. Interchemical Corp.*, 325 U.S. 327, 65 USPQ 297 (1945)).

Claim 11 is rejected under 35 U.S.C. 103(a) as being unpatentable over Applicant's Admitted Prior Art (APA) in view of Lu et al. (U.S. 6,440,836) as applied to claim 11 above, and further in view of Higdon et al. (U.S. 6,375,062).

Regarding claim 11, APA and Lu et al. together teach the process of claim 9, but do not teach that the under-bump-metallurgy is a titanium/nickel-vanadium alloy/copper composite layer when the bonding pads are made of copper.

Higdon et al. teaches a solder bumping method that uses copper bonding pads wherein it is particularly suitable to use a titanium/nickel-vanadium alloy/copper composite layer for the under-bump-metallurgy layer (column 4, lines 34-38 and 54-58).

Therefore, at the time of the invention, it would have been obvious to one of ordinary skill in the art to form a solder bump according to the process taught by APA and Lu et al. together, and also taught by claim 9, and further make the bonding pads of copper and the under-bump-metallurgy of titanium/nickel-vanadium alloy/copper composite. The motivation for doing so at the time of the invention would have been that Higdon et al. teaches that this under-bump-metallurgy layer is particularly suitable in bump-forming processes. Further, it has been held that the selection of a known material based on its suitability for its intended use supports a prima facie obviousness determination (*Sinclair & Carroll Co. v. Interchemical Corp.*, 325 U.S. 327, 65 USPQ 297 (1945)).

Response to Arguments

Applicant's arguments filed 12/14/2005 have been fully considered but they are not persuasive.

On page 9, Applicant argues that Lu et al. teaches forming a first photoresist layer **90** is formed on the diffusion barrier layer **84** for patterning the diffusion barrier **84** (fourth full paragraph). However, Lu et al. also teaches forming an optional wetting layer not shown in Fig. 3, but considered part of the BLM layer **80** (column 7, line 67-column 8, line 1). Assuming the presence of this wetting layer, the photoresist layer **90** is formed on the diffusion layer **84** and directly on the wetting layer.

In the same paragraph, Applicant further argues that Lu et al. teaches forming a non-leachable metal layer **96** covering the diffusion barrier layer **84** and the adhesion layer **82**, and that the photoresist layer **100** is clearly formed on the non-leachable metal

layer **96**, and not on the adhesion layer. However, Lu et al. expressly teaches that the non-leachable layer **96** is optional (column 8, lines 24-30), and in its absence, the photoresist layer **100** is formed on the adhesion layer **82**.

On pages 10 and 11, Applicant argues that Lu et al. teaches electroplating or electroless plating the solder material, while claims 1 and 13 require a printing process to deposit the solder material. In light of this argument, the rejection of claims 1 and 13 above is changed from that made in the previous Office action, and this action is made non-final to allow Applicant to respond. However, even though Lu et al. teaches a plating method of depositing solder, there is nothing in the method taught by Lu et al. that precludes other forms of solder deposition, such as a printing process. Indeed, aside from the method of depositing the solder bump, the method taught by Lu et al. is virtually the same as that recited in the instant claims 1 and 13.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Heather A. Doty, whose telephone number is 571-272-8429. The examiner can normally be reached on M-F, 8:30 - 5:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Carl Whitehead, Jr., can be reached at 571-272-1702. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

had

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